PA-772

Sta

our struggle against pests

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U.S. DEPARTMENT OF AGRICULTURE • OFFICE OF INFORMATION • PA NO. 77

foreword

IF YOU have ever said of a classmate, "He's a pest!" you probably meant that he annoys you. The kind of pests that attack our crops and forests are much more than an annoyance. Unless controlled, they become plagues that can wipe out much of our food supply. They have caused famine and death.

The pests that concern the farmer and the consumer (all of us) are those insects, plant diseases, and weeds which damage, destroy, or prevent the growth of food and fiber-bearing plants. Of equal concern are those pests which injure or kill farm animals and wildlife. Some insect pests attack people directly and carry disease—mosquitoes, houseflies, chiggers, leeches, bedbugs. Cockroaches and ants are undesirable houseguests. And one stays clear of the three-leafed weed pest poison ivy.

Some of the world's finest scientists are searching for the best ways to control these pests. Some day you may be one of them. Meanwhile, you are, like the scientist, a citizen and a consumer who must pay for what the pests destroy. You may also look about you and wonder, as more babies are born and the population increases, if people in the United States will always have plenty to eat at prices they can afford to pay. You know that many people in some parts of the world do not, and you wish you could help them.

More people must be fed. At the present rate of growth, world population will increase as much in the next 35 years as since the beginning of civilization. From the current 3.3 billion it will rise to nearly 7 billion people by the year 2000. You who read these words—if you have normal life expectancy—will be living then, and you will not be old.

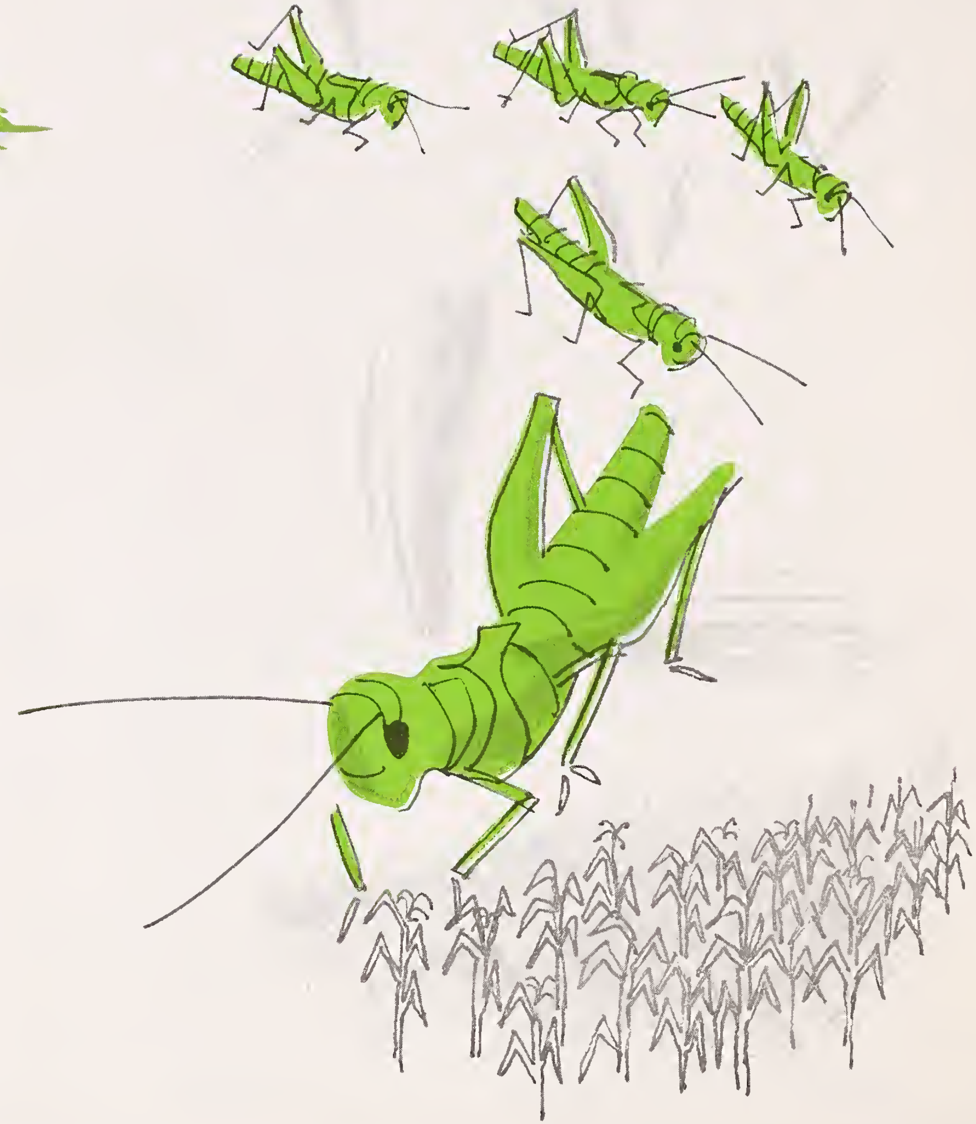
Control of crop and livestock pests is necessary for high food production anywhere in the world. Food supply is basic to life and everything man does. So the story of pests is not a simple story. It has many heroes and a great many villains. It has much conflict, many surprises, some disasters. But it's a hard story to tell because it lacks one element all good stories must have:

This story has no ending.

And it never will have unless you and other young readers, as informed citizens or scientists, help to write it.

our struggle against pests

an introduction for American youth



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little enemies

IMAGINE 250 B-52 bombers, fully loaded, sweeping down to attack—of all things—a wheat field! A single flight of locusts (grasshoppers) can weigh 50,000 *tons,* as much as such a flight of bombers. This is a *great* many grasshoppers, but there are many, many times that number eating away in the United States today, most of them in the western two-thirds of our country. They have been observed flying in such thick masses that they dim the sun. They severely damage range grasses and cultivated crops such as alfalfa, corn, small grains, and flax. Their ravenous appetites contribute to soil erosion and "dust-bowl" conditions, causing millions of dollars' worth of damage every year.

Fifty thousand tons of grasshoppers, each consuming its own weight in food daily, would take the food of 5 million humans per day. That's roughly equivalent to the combined populations of Delaware, Idaho, Maine, Montana, Nevada, New Hampshire, North Dakota, and South Dakota.

Most insect pests are tiny, smaller than grasshoppers, but a million of them make a hungry giant. Many millions make an army of giants—and their existence is real, not imaginary. Insects multiply with incredible speed. The weight of their total numbers is beyond imagining. In one summer season from April to August, the descendants of one pair of houseflies, if all lived and reproduced normally, would make a total of 191,000,000,000,000,000,000. That's 191 quadrillion, a figure that only a computer could handle.

No one knows how many species of insects share this earth with us. Estimates range from 3 to 10 million. Every year thousands of new species are discovered.

Insects are an infinitely varied lot. Many species—many hundreds of thousands—are harmless or useful to people. Some insects can live in water nearly boiling hot; others survive at freezing temperatures. Some insects thrive on opium, nicotine, or strychnine, and a few make their homes in the corks of cyanide bottles. At least six different kinds of insects inhabit wine bottle corks; the diet of one species of beetle consists almost solely of cayenne pepper.

Of the multitudes of insect species some 10,000 are known to be damaging to crops, forests, and livestock. Among these, several hundred species in the United States are particularly destructive and would take more of the crops than the farmer if he and others did not

fight them. The competition of people with pests for food is a life-and-death struggle. Many times the pests have won.

Notable "public enemies" among crop insect pests are corn rootworms, corn earworms, boll weevils, cotton fleahoppers, thrips, and spider mites. The two-spotted spider mite causes great damage to spearmint and peppermint crops. Cutworms, leafhoppers, the rednecked peanut worm, thrips, and white-fringed beetles damage peanut crops.

Green bugs damage barley, oats, and wheat in various parts of the Great Plains north to Canada. The hessian fly is one of the most destructive insect enemies of wheat. The wheat stem sawfly is a destructive pest of wheat in northern North Dakota and Montana.

Rice is attacked by the rice stink bug and the rice water weevil. Soybean plants are unable to defend themselves against the bean leaf weevil, garden fleahopper, Mexican bean beetle, mites, stink bugs, and velvet bean caterpillar.

Some insects have a sweet tooth. Sugarbeets are favored by caterpillars of various kinds. The beet leafhopper also feeds on seedlings but, more important, it carries a disease called curly top which is very destructive to sugarbeets. Sugarcane is attacked by the sugarcane borer.

The list of injurious insects could go on and on. Fruit trees are beset by a variety of mites and scale insects. Cherry trees, for example, are attacked by the black cherry aphid, cherry fruit fly, cherry fruitworm, eyespotted bug moth, leaf rollers, mites, peach twig borer, and tree borers. Special armies of insects—such as potato wireworms, cabbageworms, cutworms, and leafhoppers—are constantly moving against vegetables.

And insects are not the only crop pests. Some 1,500 kinds of nematodes (worms too small to be seen without a microscope), 600 species of weeds, and at least 1,500 types of plant diseases thrive at the expense of the farmer and other consumers.

Because our farmers have safe and effective ways to control these pests, food is better, cheaper, and more abundant in the United States than anywhere else in the world. Farmland in many countries produces small amounts of food per acre because the farmers do not use modern agricultural methods, including pest control. Without such methods, our farmers could not produce enough food for our own people, much less help to feed some of those in other countries who have far from enough.

disease—a silent enemy

SOMEWHAT LIKE people, plants get sick. The kinds of illnesses they have are much different, of course. Plants with diseases almost never get well. The simplest way to define plant diseases is "abnormal growth or structure of plants." The best "cure" is to prevent them from getting them. In many cases, insects transmit diseases, or make it possible for diseases to take hold.

In general, plant diseases are caused by bacteria, fungi, and viruses. Some fungi have big names, hard to pronounce and easy to forget. *Fusarium, Rhizoctonia,* and *Sclerotinia* are examples. Nearly every species of plant is subject to several types of diseases.

Can you imagine a sick bean? It isn't a funny thought for the man who raises them. Beans have no feelings, but the farmer who raises them as a crop has strong feelings about losing much of it. The consumer may have strong feelings about the price he has to pay for beans at the store.

The list of bean diseases is long and varied. Some of the common names of bean diseases are frightening—Fusarium rot, Sclerotinia wilt, bacterial blights, Rhizoctonia root rot, anthracnose bean yellow mosaic, common bean mosaic curly top, rust.

Every useful plant is subject to a similarly long list of diseases. Some varieties of some plants have been

developed which are resistant to some diseases. Others—nearly all—must be treated. If they are not, they will not bear as much food and it will not be as good.

At different times and in different regions, new types of diseases occur. Both insects and diseases which had not before been a problem in some areas suddenly become so when diseased plants and damaging insects are accidentally brought into a region. Insects and plant diseases often combine to damage crops. One weakness in a plant brings on another.

Much the same is true of livestock, poultry, and wildlife. All are subject to diseases which, if not controlled, will destroy countless numbers. Some infectious diseases of animals strike like lightning and spread almost as fast. *Vesicular exanthema,* a virus disease of hogs, was a relatively unimportant disease confined to California until 1951. Then it suddenly flared in other states, requiring a costly program to halt it.

Foot-and-mouth disease, which strikes cloven hoofed animals, sounds slight, but the thought of it sends a chill of fear down the backs of cattlemen and all who know its horrors. The disease is prevalent in the Soviet Union, countries of Eastern Europe, and elsewhere. If it enters and becomes established in the United States, as it well might do, it will require emergency action comparable to defense against biological warfare. Whole regions of the country will be sealed off from travel; all forms of transportation will be halted; automobile tires and peoples' shoes will be scrubbed with powerful disinfectants. There will be no steaks or other beef products except at high prices. Worst of all, entire herds which have foot-and-mouth disease—perhaps hundreds of thousands—will be destroyed. So terrible and so contagious is this disease there is, at present, no other wholely effective way to stop it.

Pestilence builds upon pestilence. The livestock screwworm pest, while not an infectious disease, spreads much like one. The bite of a single tick, or any small wound, gives the screwworm a chance to do his nasty work. About three times the size of a house fly, the screwworm imbeds itself in broken flesh and eats away at the surrounding area. Its ravages, if undeterred, can kill a full-grown steer in 10 days.

Last but by no means least, there are those pest-carried diseases which afflict humans. How many people have died after being infected by mosquitoes that carry malaria and yellow fever? How many lives have been saved because these carriers were discovered and—in some regions of the earth—eliminated? During World War II and the Korean conflict, DDT and other pesticides protected both fighting men and citizens from diseases transmitted by insects, lice, ticks, mites, and rats. New attacks of malaria and typhus are rare today in the United States.

But pest-carried disease, a silent enemy, waits to strike again. We cannot relax our vigilance.

plants nobody loves

EVERYBODY KNOWS what a weed is—or does he? Plant scientists are usually careful about definitions, and they say, simply, "Weeds are plants growing where they are not wanted."

Some plants commonly called weeds in the United States are barnyard-grass, crabgrass, morning-glory, and pigweed. Others are cocklebur, goose grass, foxtail, milkweed, sowthistle, sunflower, trumpetvine, and quackgrass. You may also hear of bedstraw, chickweed, henbit, red sorrel, smartweed, wild mustard, and whitetop. All of these plants have a habit of growing where they are not wanted.

Have you ever seen the pretty witch, called witchweed? Perhaps you have if you have ever visited North Carolina and South Carolina. It has a vivid red bloom and appears quite innocent. But it is a killer, a strangler of corn, sorghum, and sugarcane. Witchweed, which was brought into this country from Africa, may be losing ground in the battle being waged against it by a joint Federal-State control program. The main control has been the herbicide chemical, 2, 4–D, to kill the parasitic plants before they produce seeds.

The job is not easy. A single witchweed plant, during one growing period, produces as many as a half million almost microscopic seeds. Because the seeds are so tiny, they are easily scattered by wind, water, animals, and farm implements. They can lie dormant for years, then suddenly come to life when the roots of a host plant comes near them. Many weed plants are similarly hardy.

Weeds harm desirable plants by taking their food, water, light, and space. Weeds harbor insects, nematodes (tiny worms), and disease-producing organisms. They also clog farm ponds, recreational lakes and streams, and irrigation and drainage ditches. The result of their being where they are not wanted (and most of them are not wanted anywhere) is reduction in the quality and quantity of crop and livestock products. Weeds also may impair the health of humans.

In one way or another, the control of weeds costs you and your parents a great deal of trouble and money. If you have ever tried to keep a home lawn free of weeds, such as crabgrass, you have experienced a small sample of the trouble. Your parents know the cost. (If you have ever rubbed against the shiny three green leaves of poison ivy, you also know the cost—and it isn't merely money. Poison ivy causes pain and annoyance, to say the least. For some people, it causes severe, even fatal, illness.)

the longest war

WHEN MAN the Hunter became Man the Farmer, he began to create conditions which altered plant life, and the life of other organisms, as well as his own. Insects, diseases, weeds, and microscopic worms often find conditions more favorable for their survival in farming regions than in areas where nature has been left undisturbed. Having created ideal conditions for the multiplication of weeds and other pests, Man the Farmer, and Man the City Dweller, must now find efficient means of controlling pests if he is to keep his dominant position on earth.

Farmers have been fighting pests ever since farming began. For many centuries they fought barehanded—pulling weeds by hand, plucking and shaking insects from plants by hand. Then there was that superb tool, the hoe—and eventually other tools for tilling and cul-

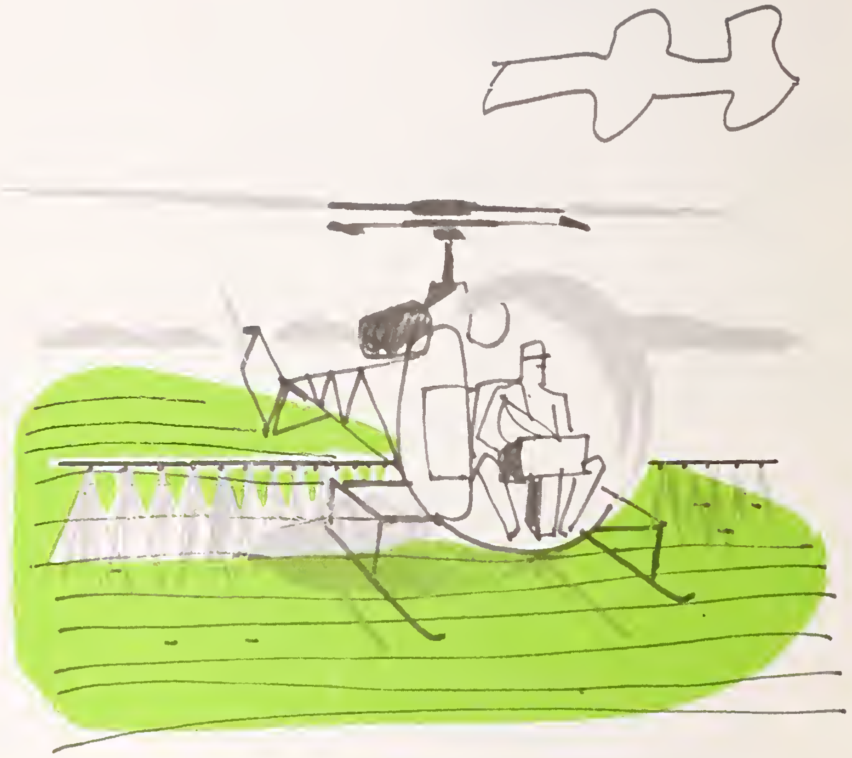
tivating the soil. Salt was probably the first chemical weed killer. The ancient Greeks also used brimstone (sulphur) against some insect pests.

But such efforts were feeble and only slightly successful. Pests often got the upper hand. Men were helpless to fend off plagues of insects and disease. For thousands of years they regarded such disasters as fate, about which they could do nothing.

A hundred years ago, settlers on the Great Plains used a chemical compound called Paris green, containing arsenic, to save their potato crops from the Colorado potato beetle. They put copper sulphate on grain seed to protect growing grain from plant diseases. They engaged in "hand-to-hand" combat with pests too. They dug ditches around their crops and, when that failed, moved to new fields. They also "used up" the land and moved on to other regions.

Early farmers in the United States lacked the means and methods to keep the war against pests on even terms and to conserve the land. Crop yields per acre were low. Sometimes there was none; pests and other calamities took all of it. Pests commonly took more than half of the crops of nineteenth century farmers. Early twentieth century farmers were only a little luckier.

For the first time in world history, the war against pests turned in favor of the farmer (and the consumer) in the early 1940's. The turning-point was the development and use of new types of chemical pesticides.



The term "pesticide" is applied to a variety of chemical compounds used to control all kinds of pests. It includes insecticides used against harmful insects, herbicides which kill weeds, nematocides for control of microscopic worms called nematodes, fungicides which control plant diseases, and rodenticides for doing away with rats, and other rodents.

The chlorinated hydrocarbons are compounds of carbon, hydrogen, and chlorine. One chlorinated hydrocarbon nearly everyone has heard of is DDT. (The chemical name of DDT is 1,1,1-trichloro-2,2-bis (*p*-chlorophenyl) ethane and don't you *ever* forget it.) There are numerous other pesticides in the chlorinated hydrocarbon family. Another large group of pesticides are organic phosphorous compounds, composed of phosphorous, oxygen, carbon, and hydrogen. In 1966 there were 69,000 different kinds of pesticide formulations registered, after thorough tests of their safety and effectiveness, with the U.S. Department of Agriculture.

Pesticides with a long history of use include compounds with such names as copper sulphate, arsenate of lead, and zinc phosphide. Pesticides which have come into widespread use since the early 1940's are the chlorinated hydrocarbons, used against insect pests.

Private users on farms, and in forest, gardens, and homes, apply about 95 percent of all pesticides used in the United States. Usually the private farmer sprays only his own crops from ground vehicles (leaving pests in his neighbor's fields to survive and move to his own). Some pesticides are applied by one man on foot carrying the necessary equipment and wearing adequate protection. Airplane spraying is possible only for large areas, and its cost usually must be shared by groups of producers, by agencies of Federal, State, and local governments, or—as is most often the case of a large-scale effort to control crop pests—by a carefully planned, cooperative program.

Pesticides are used by people other than farmers, of course. Possibly you have used them to kill insects around a campsite or around your home. Enough aerosol pesticide spray cans are sold each year to allow more than one to a family. Pesticides are also used to control rats, ants, houseflies, mosquitoes, cockroaches, bedbugs, and other pests which plague urban as well as rural areas.

The use of chemical pesticides has done a great deal of good in the past 20 years. Together with other improved agricultural methods, modern pesticides have helped to increase farm output per acre by at least a third. They have helped to produce, protect, and improve the quality of our food. For all consumers they have helped to keep food costs down and food quality high. They have served everyone also in suppressing pests that transmit malaria, yellow fever, typhoid, and many other diseases.

Pesticides are used in ways directly beneficial to wildlife. For example, they are used to eliminate poisonous plants and brush from rangeland, permitting better grazing for antelope, deer and elk, which are thriving in greater numbers than ever before. Pesticides are used to cut down the growth of weeds in ponds, lakes, and streams, permitting the growth of food plants needed by fish. Plant diseases, insects, weeds, and other pests which are harmful to man, livestock, farm crops, and forests are usually harmful to wildlife as well.

Nevertheless, chemical pesticides are poisons. That is why they are effective for the use they are intended. Like many modern drugs and machines, pesticides are dangerous if they are carelessly or improperly used. In some instances, what was thought to be proper and cautious use of a pesticide has resulted in the death of beneficial insects, fish, and birds. Some pesticides leave a lasting residue which may move in water, air, and food into the bodies of animals, including man. This is of serious concern to scientists and all others whose first interest is human welfare.

Every possible precaution is being taken to make certain that pesticides, properly used, do *not* harm humans in any way, nor adversely affect any plant or living creature which contributes to the support of human life. Chemical pesticides are powerful substances that serve man in many ways. Their use as a major weapon in the control of crop pests will likely continue for many years. For this reason—and because the benefits are so apparent, the possible dangers less so—the use of chemical pesticides should not be taken lightly by any citizen, young or old.

The U.S. Department of Agriculture's basic purpose is "to acquire and diffuse useful information on agricultural subjects in the most general and comprehensive sense." To insure the Nation an abundant and wholesome supply of food, it seeks to eradicate and control plant and animal diseases and pests. In achieving effective pest control, it has important responsibilities in three areas besides education: Regulation, direct control, and research.

In each of these areas the Department works with other Federal, State, and community agencies; with educational institutions and organizations; and with private industry. In every county in the United States, the Department's representative is the county agent, who serves farmers and other consumers as well.

In the direct control of pests, the Department uses, and encourages others to use, control methods which will do the job with the least risk to man and wildlife. Meanwhile, it conducts and supports scientific research to find better chemical methods and better non-chemical methods of pest control. And it continues to perform its important role of watchdog in the registration, labeling, and use of pesticides.

keeping people safe

MANY THINGS intended for a good purpose may be dangerous to human life. Electricity, for example, can kill, but properly used and controlled, it is a valuable servant. Few people would prefer to be without electricity. Aspirin and many other simple medicines, improperly used, have taken the lives of many thousands. So have alcohol, cleaning fluids, and many other drugs and chemical compounds found in most homes.

No one in this world is wholly safe at all times.

Long ago, the Congress of the United States took steps to insure that our food be wholesome and safe to eat, and that it contain no pesticide residue, nor any other chemical compound, in amounts known to be harmful. Further, Congress provided for a continuous and close watch on the matter, and for constant revision and enforcement of appropriate regulations.

The Food, Drug, and Cosmetic Act of 1938, as amended, assigns the responsibility for the safety of foods containing pesticide residue to the Department of Health, Education, and Welfare. The Secretary of that Department has delegated the responsibility to the Food and Drug Administration.

The Federal Insecticide, Fungicide, and Rodenticide Act of 1947 assigns the responsibility for pesticide control to the Department of Agriculture. Under this law,

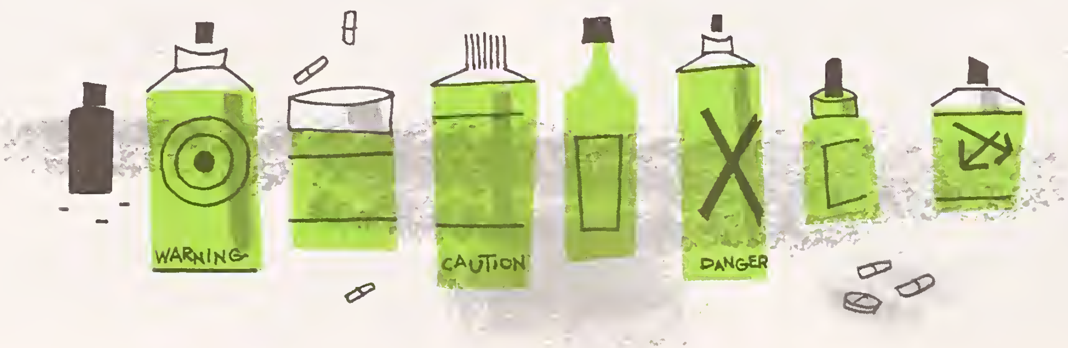
every chemical pesticide shipped in interstate commerce must be registered with the Department before it can be sold. Before registration is granted, a pesticide must pass rigid tests, proving that it will aid in the control of pests and that it is safe, when used as directed, to humans, crops, livestock, and wildlife. Three Departments of the Federal government—Agriculture, Health, Education, and Welfare; and Interior—now review all pesticide registration applications and evaluate the possible effect of the use of the pesticide on human health and wildlife.

The Department of Agriculture regulates the labeling of pesticide products. The law requires that a warning of possible danger must appear, when needed, on the label of pesticide products. The label must also bear a registration number indicating that the product has been accepted as adequate to permit both safe and effective use when directions are followed.

Anyone using any pesticide should read carefully the directions on the label and follow them. They were placed there only after the most thorough study and examination by scientists working for the people through Federal agencies and by scientists employed in the chemical industry.

Private industries spend millions of dollars in the research, testing, and development of new pesticides before they apply to the Department of Agriculture for registration. They must provide sound scientific evidence that the product they want registered is safe and effective. Unless every prescribed standard of evaluation is met, the Department of Agriculture will not permit it to be registered and sold.

The words on the label of a registered pesticide are among the most costly ever written, each word representing many thousands of dollars' worth of investment in research, testing, and study by agents of the govern-



ment and private industry. What is far more important than the expense is that the product be safe for people to use as directed and that it does what it claims to do. To benefit from all this precaution, users of a pesticide must read the label—read it more than once—then handle the product precisely according to directions.

The Food and Drug Administration, in carrying out the responsibilities assigned to it by the Food, Drug, and Cosmetic Act, sets safe limits on the amounts of pesticide residue that may remain on crops shipped across state borders. This established limit of allowable residue is called "tolerance." It is determined by many studies, among them those which show the largest amount of the chemical that will cause no injury to test animals if they consume it for an entire lifetime. If all reasonable doubt is resolved in favor of consumer safety, then a tolerance is set for specified crops and food products. The tolerance amount is set at the lowest level that will accomplish the intended purpose, even though a larger amount would still be safe.

Just as important as establishing tolerances is making certain they are not exceeded. This is done by a process called monitoring, of which there are several types for different but related purposes.

Monitoring for pesticide residues means, in general, *watching* with every available scientific means what the residue of pesticide does—in organisms, soil, water, and food. This watchfulness is necessary to evaluate its effects, if any, on all living creatures, and to improve methods of pesticide application so that only beneficial results will be obtained.

The Food and Drug Administration continuously monitors foods for possible harmful amounts of pesticide residue. In a typical year the Administration's laboratories analyzed more than 30,000 samples of raw agricultural commodities and found only 34 lots containing a high residue (in relation to the cautious tolerance allowable). These lots were seized by Federal Court actions and either washed until safe or destroyed.

The biggest eater in America is the average 16-to-19-year-old boy. FDA researchers periodically make a detailed analysis for pesticide residues in the total amount of food such a boy would eat over a period of time. This total diet study covers foods marketed in

five different areas of the country. In all tests the amounts of pesticides found have been so small as to present no public health danger.

The Department of Agriculture, and usually non-Federal conservation agencies, monitors every direct control program in which it takes part for adverse effects on wildlife, fish, and beneficial insects. From the first, each program is planned for maximum safety to wildlife. Each program provides information to make future programs safer and more effective.

The Department's scientists are also engaged in monitoring for the possible presence of pesticide residue in samples of soil, water, sediment, crops, and certain land and water animals at a wide range of locations across the nation. Field teams, each supervised by an entomologist, collect samples and send them to a laboratory in Gulfport, Mississippi, where they are chemically analyzed for pesticide content. The men also make counts of insects to see what effect the use of pesticides has had on the insect population. The counts include both nuisance insects, such as flies, ticks and mosquitoes, and beneficial insects, such as the honeybee. If they found the pesticide residue at any location significantly increasing there would be an immediate alert and action taken to correct it.

The Public Health Service of the Department of Health, Education, and Welfare is similarly engaged in a nation-wide program to analyze and evaluate both long- and short-term effects, if any, of the use of pesticides on the human body. Public Health Service researchers are investigating the possible relationship between pesticide exposure and human illnesses, studying pesticide effects upon several generations of warm-blooded animals, and the effects on man of combinations of pesticides, or combinations of pesticides with drugs and other chemicals.

The Public Health Service also has a responsibility to record and investigate illnesses or deaths believed to have been caused by accidental poisoning involving pesticide chemicals. As with drugs and other toxic substances used around the home, the most frequent victims of such accidents are inquisitive young children who eat or drink such substances. That's why it's important that you make sure all chemical products are placed out of the reach of your small brothers and sisters.

The U.S. Interior Department, largely responsible for the management of much of the nation's natural resources, is engaged in obtaining an accurate measure of pesticide hazards to wildlife. Scientists in the Department, particularly those of its Fish and Wildlife Service, study the effect of pesticides on the behavior and reproduction of animals and the significance of residues in fish and wildlife. Their objective is to protect wild animals, birds, and fish from pesticide residue wherever it appears to be a danger.

meeting the enemy

WHEN ANYONE enters this country from abroad, an inspector of the U.S. Department of Agriculture may not actually ask, "Do you have any bugs, weed seeds, or plant diseases?" but that is what he has in mind. He may seem casual, but he knows exactly what to look for and how to look for it.

About one-half of our most destructive crop pests have been brought into the United States—unintentionally, of course—from other countries. To keep pests from entering, and to prevent their spread from one State or region to another, Congress passed the Federal Plant Quarantine Act in 1912. (The action was late. At that time, many of the worst crop pests had already found a home here.)

Today, inspectors of the Department of Agriculture at 70 checkpoints—seaports, international airports, and border crossings—examine all incoming baggage, cargo, stores, and mail for hitchhiking pests. While the inspectors have sharp eyes and other means of detection, a major pest sometimes manages to get past them. When it does, the cost to the farmer and other taxpayers is high.

In 1956, the Mediterranean fruit fly got into Florida and began to multiply with a speed comparable to the acceleration of a space rocket. It took a Federal-State program costing $10 million to stop the fruit fly, but it would have cost the Florida fruit industry (and, indirectly, the consumer) $20 million a year to live with it.

Witchweed's native home is in regions of South Africa, but it can be found in 35 counties in North and South Carolina. More than $18 million has been spent to fight this witch. It still survives.

Because there are so many ways for a new pest to hitchhike into the country and the cost of the damage it can do is so great, agricultural inspectors cannot be lax, but their jobs are lightened by unusual incidents:

- A 7-foot tiki (wood image of a Polynesian god) almost got the ax in San Ysidro, California. Carved from a palm stump with roots as the hair, the idol was not allowed to enter the United States until its youthful owners removed all soil from the roots. (Tiny worms, larvae, or weed seed can hide in a speck of soil.)
- An inspector in Seattle broke up the friendship between a member of a ship's crew and his pet grasshopper. The hopper belonged to a species that causes destruction in China and Japan but is not found in the U.S.
- To avoid giving up his apricots in Chicago, one traveler began eating them. He turned a sickish green after the inspector broke open one apricot and revealed insect larvae inside.

During a recent year, Department of Agriculture inpectors prevented the entry of 38,461 insects, diseases, and other plant pests, and 401,392 lots of prohibited plants. They examined ships, planes, trains, cars, and—in cooperation with customs inspectors—nearly 32 million pieces of passenger baggage. Animal quarantine inspectors, checking animals shipped to the United States, turned back more than 23,500 because they carried disease or other livestock pests.

Farmers are on the front-line in the battle against pests which have long lived in this country or have recently become established. With them are the ranchers and the managers of timbering concerns.

The Department of Agriculture joins in the fight directly only when it cannot be fought adequately by individual, municipal, or State action. (Agencies of the Federal government use less than 5 percent of the pesticides applied each year. The rest is used by private individuals and organizations.) The fruit fly control program in Florida is an example of the projects conducted jointly with a State by the Department's Agricultural Research Service and Forest Service. Private groups, including producers, conservationists, and other affected citizens, may also participate in such a program.

The Department's Forest Service has the responsibility for promoting the conservation and best use of forest lands. The Service administers 154 national forests, comprising over 181 million acres, in 39 States

and Puerto Rico. Among its many duties in the management of our national forests is protecting them from fire, insects, and disease.

Often the Forest Service fights the brown spot disease with fire, through carefully managed controlled burnings. Forest Service lumberjacks often log out dead trees infested with disease. The Service also engages in direct combat with forest pests through carefully planned and supervised programs of pesticide spraying from low-flying airplanes. However, less than three-tenths of one percent of national forest acreage is treated with pesticides in any one year.

All Federal pest control activities are coordinated by the Federal Committee on Pest Control (FCPC). The Committee is composed of representatives from the Departments of Agriculture, Defense, Interior, and the Department of Health, Education, and Welfare. Each year they review a variety of pest control proposals to offer judgment on their safety and effectiveness. Among pest control campaigns in which the Department of Agriculture has engaged that have been reviewed by FCPC in recent years are those against the cotton boll weevil in Texas and New Mexico, grasshoppers in the Western and Central States rangeland, cereal leaf beetle in Indiana, Michigan, and Ohio, and the gypsy moth on hardwood forests in the Northeast. The Committee also has reviewed the Department's participation in attacks against the Douglas-fir tussock moth in Oregon, California, and Idaho, fall cankerworm in Pennsylvania, the Great Basin tent caterpillar in Arizona, tree-killing bark beetles in western and southern States.

The Department of the Interior works to control pests directly in a variety of interesting ways. The Department's Fish and Wildlife Service uses pesticides to control weeds in irrigation canals, mosquitoes in campgrounds, certain kinds of "rough" fish that crowd out desirable ones in lakes and streams, and for several other purposes. The Service also has the most difficult task of controlling animal and bird pests.

To combat animal pests, the Interior Department has under its supervision some 500 hunters and trappers in 14 western States. Like mountain men of the frontier days, these hunters trap and kill foxes, coyotes, bobcats, and other animals that prey upon livestock.

The concern of the Fish and Wildlife Service ranges from this old and primitive defense against predator animals to protecting pilots and passengers of jet aircraft menaced by birds. The high speeds that planes fly today make the impact of striking a bird in flight sufficient to cause a crash. This is no fault of the birds, but it is a clear danger to airplane passengers nonetheless.

When jet aircrafts at a Boston airport were menaced by sea gulls being sucked into their engines on take-off (endangering human lives and damaging jet engines), the Fish and Wildlife Service learned that the sea gulls nested on nearby islands. Field men released two raccoons and two foxes on each of two small islands off the coast of Massachusetts. The animals ate sea gull eggs all summer and reduced the gull population by 90 percent. When winter came, the foxes and raccoons had to be removed from the islands, for having consumed all the food available for them they would have starved.

Man, by his inventions and efficiency, constantly creates new threats to his well-being which must be met. The development of winter livestock feeding pens in Colorado, for example, has provided a winter supply of food for hordes of hungry blackbirds, who eat much of the grain and ruin a great deal more. Without this food to sustain them, many of the birds would not survive the winter. With it, millions more live to hatch their eggs in the north central States. Their numbers thus abnormally increased, the blackbirds then fly down to Louisiana to fatten themselves on the rice crop. To help control such bird pests, the Denver Center of the Fish and Wildlife Service has developed a chemical pesticide, or avicide, for use against blackbirds and starlings. Several non-chemical methods to control pest birds, such as bird traps, have also been developed.

The direct pest control efforts of the Public Health Service of the Department of Health, Education, and Welfare are aimed chiefly against those pests which carry human diseases. The public health flank of the attack is vast and important, a concern of private medical institutions as well as public, and it is often carried out by the public health services of State and city governments. The Public Health Service explores and demonstrates ways to control mosquitoes, flies, fleas, cockroaches, bed bugs, ticks, chiggers, rodents, and other pests that endanger human health. It recognizes that effective and lasting control of these pests depends upon sanitation and the destruction of their breeding places—drainage, filling, and the proper storage and disposal of refuse. Effective control depends upon the combined use of chemical and non-chemical measures. A report of the Service's Communicable Disease Center notes, however, that pest populations cannot be decreased rapidly without the use of chemical pesticides and "where disease control is the objective, chemical means alone may suffice to disrupt the transmission cycle."

looking into the future

THE WORD PESTICIDE, which means pest killer, is generally used to refer to *chemical* pesticides. The ancient Greeks and Egyptians used chemicals against pests 3,000 years ago. While modern chemicals are our most effective means of pest control at present, there are other kinds of pesticides. A fly swatter is one; so is a rat trap—these are *mechanical* pesticides. A cat that eats a mouse is a pesticide if the mouse is a pest and not a pet. Some birds feed on harmful insects; some harmless insects feed on harmful ones. These are applications of *biological* pesticides.

There are still other kinds of *non-chemical* pesticides (including ways to control pests not yet imagined by anyone), and these are the subject of much research.

Bringing in the parasites, predators, and certain diseases of pests are important biological ways to control them. An insect pest, for example, easily takes charge in an area where he has no natural enemies. The problem is to find who or what his enemies are and to bring them in. This has been done in some areas and has helped to control a number of pests. It is an old method, in use for 75 years, but study and research are constantly in progress to improve it.

It is unlikely that the complete job of pest control will ever be done by biological pesticides alone. For one reason, insects or organisms that feed on others will not destroy all that they prey upon if doing so means an end to their food supply. Lacking any more to eat, they themselves would die.

In some instances, undesirable insects may be caused to have a disease and die. For example, a bacterium that causes "milky disease" on Japanese beetles has been used successfully against them. The bacteria are distributed in dust form on the ground. Another bacterium has been used to control the cabbage looper and the tobacco hornworm. These methods were developed by Department of Agriculture research.

Certain animals, as well as fungi, bacteria, and viruses, may be used to control weeds, but weed-eating insects are most helpful. Leaf-eating beetles were turned loose on western rangeland infested with klamath weed. They nibbled their way through 5 million acres—an area larger than Delaware and Connecticut combined—and made it profitable grazing land again.

Department of Agriculture entomologists found a flea beetle that attacks only alligatorweed. They released an army of these beetles in South Carolina where alligatorweed clogs streams. The beetles are now working for man. The Biological Control of Weeds Laboratory in Albany, California, imports, tests, and releases insects that have proved safe for controlling weeds. The

Albany Laboratory has many possibly helpful insects under study.

Another type of pest control research deals with insect attractants, or lures. Insect pests are attracted to certain plants and animals, to the opposite sex, and to lights and sound. The Pesticide Chemicals Research Laboratory at Beltsville, Maryland, takes samples of sex attractant substances from insects, learns their chemical structure, and then makes chemical compounds much like them. Scientists have learned the chemical structure of these substances in only a few female insects—the silkworm, gypsy moth, cabbage looper, the wax moth and the pink bollworm. They needed nearly a million female pink bollworms to extract less than a drop of their attractant. Using this, they discovered a way to produce the substance in the laboratory. Now any amount that is needed can be produced commercially. The synthesized attractant is called "propylure". A powerful perfume to male pink bollworms, it will be used to lure them to their death.

Department of Agriculture engineers have been experimenting with light to see if it has the power to lure insects into traps. Some insects are known to be attracted by some forms of light, repelled by others. One form of light that seems to interest some insects is near-ultraviolet (called black light because it is invisible to humans). Black light has been used by detectives in criminal investigations to reveal tell-tale stains on clothes and other objects. Why any species of insect is attracted to it no one knows as yet.

Scientists' search for answers is a detective story of the highest order. It is a detective story that never ends, for the scientists always find more questions.

Is it possible to cut down on unwanted insect population by making the males incapable of breeding? Research has disclosed the answer to this question is yes. Department of Agriculture scientists made many millions of the larvae of the livestock screwworm sterile by exposing them to radioactive cobalt. When the adult parasites are released from airplanes over areas where the spread of their numbers had to be stopped, the sterile males mated with females. Their eggs did not hatch. The result was a sharp decrease in parasite population. (Females of this particular species were known to mate only once during their lifetimes.)

Some experimenters have tested the effects of sound on insects. At the Stored Products Research Laboratory in Savannah, Georgia, Indian meal moths exposed to amplified sound laid eggs that did not all hatch. Some of the young that did emerge did not live long. The use of amplified sound is an example of an experimental *mechanical* method of controlling crop pests. Machines that remove pests from plants have also been built and tested.

Improving food supply is a matter that cuts across many branches of science, economics, and human rela-

tions. Food is important to everybody—and so is pest control. Pest control research is one of the major responsibilities of the Department of Agriculture because its first duty is to make certain the people of this nation have an abundant and wholesome supply of food, but many other agencies of Federal and State governments also have important pest control research projects.

All of these varied research programs will, in time, undoubtedly produce better methods of pest control than any known today. Of more immediate use is the development of safer chemical pesticides, which leave little or no residue on crops—and better ways to apply them. Pesticides have been developed that are very effective in extremely small quantities. Ways of applying pesticides strictly to the target area have also been greatly improved.

It is clear that a combination of all known methods of pest control and much more research will be required to continue man's endless war against pests.

Agricultural scientists now envision a new approach to pest control called Insect Population Suppression. Except for a few large-scale campaigns, pest control is applied today to only small segments of insect population at any given time—those infecting an individually owned field, farm or garden. Such piecemeal efforts are costly and, in the long run, cannot stem the tide of insect pests. They simply move from one field to another.

In population suppression, large areas would be treated, requiring the teamwork of community, regional, and national officials and the understanding and support of all citizens. For such a total attack many new and old insect control approaches would be needed. Some of these have been tested and proven; many others are still under development.

Many scientists in universities and industrial laboratories, as well as in agencies of the Federal government, are working to solve problems of pest control. Future successes in this field depend, in part, upon the development of young scientists who will devote their lives to plant and insect study. Using research plans not yet dreamed of, they will learn more about the relationships of pests and their environments and thus help to make man's hold on earth lasting and deserved.

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